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(54) Title: INHIBITION OF HAIR GROWTH

(57) Abstract

Mammalian hair growth is reduced by applying to the skin an inhibitor of a cysteine synthetic pathway enzyme.

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- 1 -

INHIBITION OF HAIR GROWTH

The invention relates to a method for the inhibition of unwanted hair growth in mammals.

5 A main function of mammalian hair is to provide environmental protection. However, that function has largely been lost in humans, in whom hair is kept or removed from various parts of the body essentially for cosmetic
10 reasons. For example, it is generally preferred to have hair on the scalp but not on the face.

Various procedures have been employed to remove unwanted hair, including shaving, electrolysis, depilatory creams or lotions,
15 waxing, plucking, and other cosmetic procedures, and therapeutic antiandrogens. These conventional procedures generally have drawbacks associated with them. Shaving, for instance, can cause nicks and cuts, and can leave a
20 perception of an increase in the rate of hair regrowth. Shaving also can leave an undesirable stubble. Electrolysis, on the other hand, can keep a treated area free of hair for prolonged periods of time, but can be expensive, painful,
25 and sometimes leaves scarring. Depilatory creams, though very effective, typically are not recommended for frequent use due to their high

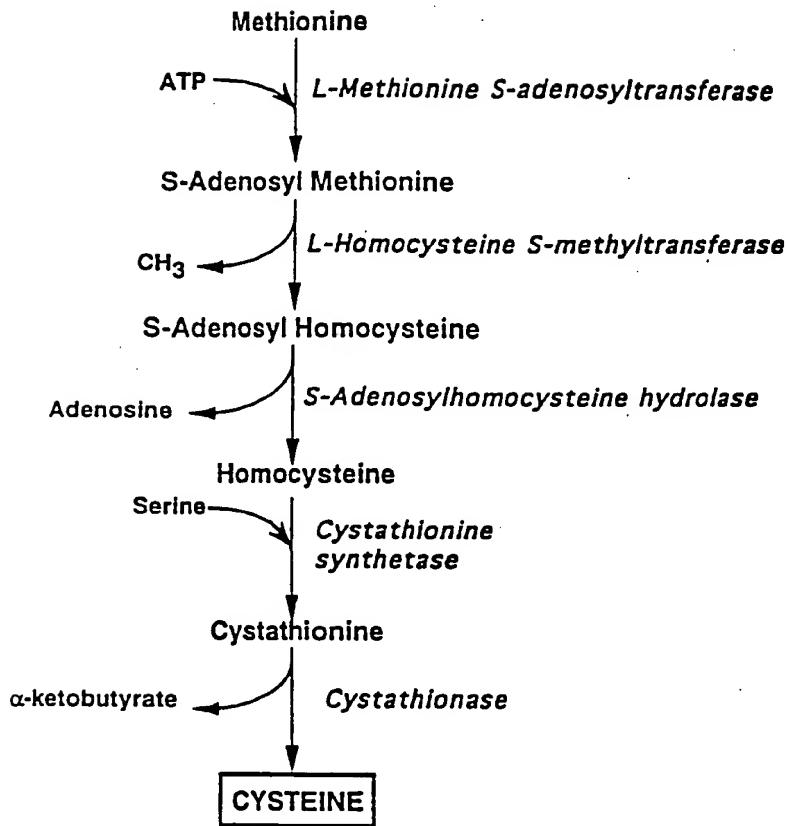
- 2 -

irritancy potential. Waxing and plucking can cause pain, discomfort, and poor removal of short hair. Finally, antiandrogens -- which have been used to treat female hirsutism -- can

5 have unwanted side effects.

- It has previously been disclosed that the rate and character of hair growth can be altered by applying to the skin inhibitors of certain enzymes. These inhibitors include
- 10 inhibitors of 5-alpha reductase, ornithine decarboxylase, S-adenosylmethionine decarboxylase, gamma-glutamyl transpeptidase, and transglutaminase. See, for example, Breuer et al., U.S. Pat. No. 4,885,289; Shander, U.S.
- 15 Pat. No. 4,720,489; Ahluwalia, U.S. Pat. No. 5,095,007; Ahluwalia et al., U.S. Pat. No. 5,096,911; Shander et al., U.S. Pat. No. 5,132,293; and Shander et al., U.S. Pat. No. 5,143,925.
- 20 Cysteine is synthesized in cells from methionine according to the following biochemical pathway:

- 3 -



- 4 -

In the initial step in the pathway, L-methionine S-adenosyltransferase converts L-methionine to S-adenosyl methionine by transferring the adenosyl moiety of ATP to L-methionine. In the second step, L-homocysteine S-methyltransferase converts the S-adenosyl methionine to S-adenosyl-L-homocysteine by transferring the methyl group of S-adenosyl methionine to an acceptor molecule present in the cell. Next, S-adenosyl homocysteine hydrolase (adenosylhomocysteinase) converts the S-adenosyl-L-homocysteine to L-homocysteine, releasing adenosine in the process. Then, cystathione synthase catalyzes the condensation of the L-homocysteine with L-serine to form L-cystathionine. Finally, cystathionase (cystathionine gamma-lyase) hydrolyzes the L-cystathionine to form L-cysteine.

The enzymes in the biochemical pathway described above will be referred to herein as the "cysteine synthetic pathway enzymes." It has now been found that unwanted mammalian (including human) hair growth -- particularly androgen-stimulated hair growth -- can be inhibited by applying to the skin a composition including an inhibitor of a cysteine synthetic pathway enzyme in an amount effective to reduce hair growth. The unwanted hair growth which is reduced may be normal hair growth, which is cosmetically reduced, or hair growth that results from an abnormal or diseased condition.

Among the inhibitors that can be used are inhibitors of L-methionine S-adenosyltransferase such as cycloleucine, selomethionine, L-2-amino-4-methoxy-cis-but-3-enoic acid, and 2-aminobicyclo [2.1.1]hexane-2-carboxylic acid; inhibitors of S-adenosyl

- 5 -

homocysteine hydrolase such as 3-deazaneplanocin, adenosine-5'-carboxaldehyde, 3-deazaadenosine, and S-3-deazaadenosyl-L-homocysteine; inhibitors of cystathionine synthase such as isonicotinic acid hydrazide, O-succinyl serine, adenosine, and 6-azauridine-2',3',5'-triacetate; and inhibitors of cystathionase such as D,L-2-amino-4-pentyoic acid (D,L-propargylglycine), β,β -dichloro-D,L-alanine, β,β,β -trifluoroalanine, and L-aminoethoxyvinylglycine. All of these compounds are known and most are commercially available. Irreversible inhibitors are preferred; reversible inhibitors (competitive and non-competitive) can also be used.

The inhibitors of a cysteine synthetic pathway enzyme preferably are incorporated in a topical composition or cosmetic composition which preferably includes a non-toxic dermatologically acceptable vehicle or carrier which is adapted to be spread upon the skin. Examples of suitable vehicles are acetone, alcohols, or a cream, lotion, or gel which can effectively deliver the active compound. One such vehicle is disclosed in co-pending application PCT/US93/05068. In addition, a penetration enhancer may be added to the vehicle to further enhance the effectiveness of the formulation.

The concentration of the inhibitor in the composition may be varied over a wide range up to a saturated solution, preferably from 0.1% to 30% by weight or even more; the reduction of hair growth increases as the amount of inhibitor applied increases per unit area of skin. The maximum amount effectively applied is limited only by the rate at which the inhibitor

- 6 -

penetrates the skin. Generally, the effective amounts range from 100 to 3000 micrograms or more per square centimeter of skin.

- The composition should be topically applied to a selected area of the body from which it is desired to inhibit hair growth. For example, the composition can be applied to the face, particularly to the beard area of the face, i.e., the cheek, neck, upper lip, and chin. The composition can also be applied to the legs, arms, torso or armpits. The composition is particularly suitable for inhibiting the growth of unwanted hair in women suffering from hirsutism or other conditions.
- In humans, the composition should be applied once or twice a day, or even more frequently, for at least three months to achieve a perceived reduction in hair growth. Reduction in hair growth is demonstrated when the frequency of hair removal is reduced, or the subject perceives less hair on the treated site, or quantitatively, when the weight of hair removed by shaving (i.e., hair mass) is reduced.

Male intact Golden Syrian hamsters are considered acceptable models for human beard hair growth in that they display oval shaped flank organs, one on each side, each about 8 mm. in major diameter, which grow thick black and coarse hair similar to human beard hair. These organs produce hair in response to androgens in the hamster. To evaluate the effectiveness of a composition including an inhibitor, the flank organs of each of a group of hamsters are depilated by applying a thioglycolate based chemical depilatory (Surgex). To one organ of each animal 25 μ l. of vehicle alone once a day is applied, while to the other organ of each

- 7 -

animal an equal amount of vehicle containing an inhibitor of a cysteine synthetic pathway enzyme is applied. After thirteen applications (one application per day for five days a week), the
5 flank organs are shaved and the amount of recovered hair (hair mass) from each is weighed. Percent-reduction of hair growth is calculated by subtracting the hair mass (mg) value of the test compound treated side from the hair mass
10 value of the vehicle treated side; the delta value obtained is then divided by the hair mass value of the vehicle treated side, and the resultant number is multiplied by 100.

The above-described assay will be
15 referred to herein as the "Golden Syrian hamster" assay. Preferred compositions provide an inhibition in hair growth of at least about 32%, more preferably at least about 50%, and most preferably at least about 70% when tested
20 in the Golden Syrian hamster assay. A number of inhibitors of cysteine synthetic pathway enzymes were tested in the Golden Syrian hamster assay; the results are provided in Table 1.

TABLE 1

<u>Inhibitor</u>	<u>Dose</u>	<u>Vehicle</u>	<u>Hair Mass</u>			<u>Percent Inhibition (mean ± SEM)</u>
			<u>pH</u>	<u>Treated (mg mean ± SEM)</u>	<u>Control (mg mean ± SEM)</u>	
3-Deazaneplanocin	5%	A	4.5	0.357±0.15	2.363±0.35	86.65±4.81
6-Azauridine-2',3',5'-triacetate	20%	A	7.0	0.455±0.05	2.372±0.14	80.25±2.37
O-Succinyl serine	15%	A	8.0	0.710±0.07	2.043±0.18	63.58±4.69
Aden sine	10%	A	4.5	1.140±0.12	2.619±0.24	55.28±4.00
1S-nicotinic acid hydrazide	20%	A	8.5	1.344±0.18	2.139±0.22	35.13±7.98
DL-Propargylglycine	15%	B	9.5	1.401±0.14	2.148±0.19	33.12±5.59
3,3,3,-Trifluoro-DL-alanine	20%	A	7.5	1.110±0.13	1.681±0.13	32.36±8.01
1S-nicotinic acid hydrazide +	10%+	B	9.0	0.920±0.29	2.385±0.74	60.72±4.69
DL-Propargylglycine	10%					

Vehicle A: Pure water (68%), ethanol (16%), propylene glycol (5%), dipropylene glycol (5%), benzyl alcohol (4%), and propylene carbonate (2%)

Vehicle B: Pure water (73%), propylene glycol (20%), benzyl alcohol (5%), and N-methyl-2-pyrrolidone (2%)

- 9 -

Topical application of compositions including 3-deazaneplanocin demonstrate that an increased dosage level of the inhibitor provided an increased inhibition in hair growth. The 5 results are provided in Table 2.

- 10 -

TABLE 2

	<u>Hair Mass</u>				<u>Percent Inhibition (mean ± SEM)</u>
	<u>Dose</u>	<u>Vehicle</u>	<u>pH</u>	<u>Treated (ng)</u>	<u>Control (mg)</u>
3-Deazaneplanocin	0.25%	A	4.5	1.889±0.15	2.213±0.08
3-Deazaneplanocin	0.50%	A	5.0	1.487±0.16	2.366±0.26
3-Deazaneplanocin	1.00%	A	5.0	1.113±0.08	35.49±4.62
3-Deazaneplanocin	5.00%	A	5.0	0.357±0.15	2.303±0.11
					50.94±4.77
					2.363±0.35
					86.65±4.81

- 11 -

Hair follicles were isolated from the flank organs which were treated with either an inhibitor of a cysteine pathway enzyme or the carrier without the inhibitor (the control). L-

- 5 Cystathionine, homocysteine, and S-adenosyl homocysteine, which are involved in a pathway leading to cysteine synthesis, were measured by an amino acid analysis method. The amino analysis of hamster flank organ hair follicles
10 was carried out using a commercially available system (Pico-Tag; Waters Associates, Inc., Milford, MA). Hair follicle amino acids were extracted with 0.1N HCL, a derivatized with phenylisothiocyanate to yield the
15 phenylthiohydantion derivatives of the respective amino acids, which were then separated by C-18 reverse phase chromatography and quantitated by in-line UV spectrophotometry.

More specifically, 250-500 μ l of 0.1 N
20 HCL was added to each flank organ hair follicle sample, followed by treatment with a sonicator device to obtain cell extracts. The cell extracts were centrifuged at 12,000 \times g for 5 min, and the recovered supernatant was filtered
25 through 0.45 μ filter. The filtrate was vacuum dried under nitrogen using the Pico-Tag work station. Samples were then derivatized with phenylisothiocyanate reagent by the procedure described in the Waters Associates Pico-Tag
30 manual. An aliquot of the derivatized sample was injected on a C-18 reverse phase column (Pico-Tag column) and the elution was carried out with a gradient buffer system. This procedure separated the amino acids L-
35 cystathionine, homocysteine, and S-adenosyl homocysteine from other amino acids present in hair follicle extracts. The amino acid

- 12 -

concentrations were determined at UV wavelength
254 nm using an in-line spectrophotometer and a
dedicated HPLC control and data analysis system
(Waters Associates). The results are provided
5 in Table 3.

TABLE 3

	<u>Dose</u>	<u>Vehicle</u>	<u>pH</u>	<u>L-Cystathione</u>	<u>Percent of Untreated Control (100%)</u>	<u>S-Adenosyl Homocysteine</u>
Vehicle control	--	A	4.5	100	100	100
3-D azaneplanocin	0.125%	A	4.5	49	--	144
3-Deazaneplanocin	0.250%	A	4.5	29	--	149
3-Deazaneplanocin	0.500%	A	5.0	12	--	218
6-Azauridine- 2',3',5'-triacetate	20%	A	7.0	60	--	--
O-Succinyl serine	15%	A	8.0	66	228	--

- 14 -

It will be appreciated by those skilled in the art that the invention can be performed within a wide range of equivalent parameters of composition and conditions without departing from the spirit or scope of the invention or of any embodiment thereof.

- 15 -

C L A I M S

1. A method of inhibiting mammalian hair growth which comprises
 - selecting an area of skin from which reduced hair growth is desired; and
 - applying to said area of skin an inhibitor of a cysteine pathway enzyme in an amount effective to reduce hair growth.
2. The method of claim 1, wherein said inhibitor is cycloleucine, selenomethionine, L-2-amino-4-methoxy-cis-but-3-enoic acid, 2-aminobicyclo[2.1.1]hexane-2-carboxylic acid, 3-deazaneplanocin, adenosine-5'-carboxaldehyde, 3-deazaadenosine, S-3-deazaadenosyl-L-homocysteine, isonicotinicacid hydrazide, O-succinyl-serine, 6-azauridine-2',3',5'-triacetate, adenosine, D,L-2-amino-4-pentynoic acid, β,β -dichloro-D,L-alanine, β,β,β -trifluoroalanine or L-aminoethoxyvinylglycine.
3. The method of claim 1, wherein said inhibitor is an inhibitor of L-methione S-adenosyltransferase, an inhibitor of L-homocysteine S-methyltransferase, an inhibitor of S-adenosyl homocysteine hydrolase, an inhibitor of cystathionine synthase or an inhibitor of cystathionase.
4. The method of claim 1, wherein said inhibitor is an irreversible inhibitor.
5. The process of claim 1, wherein said inhibitor is applied as part of a composition including a dermatologically acceptable vehicle.
6. The method of claim 5, wherein the concentration of said inhibitor in said composition is between 1% and 30%.
7. The method of claim 5, wherein the composition provides a reduction in hair growth of at least 30%, preferably at least 50%, more

- 16 -

preferably at least 70%, when tested in the Golden Syrian hamster assay.

8. The method of claim 1, wherein the inhibitor is applied to the skin in an amount of
5 from 100 to 3000 micrograms of said inhibitor per square centimeter of skin.

9. The method of claim 1, wherein said mammal is a human.

10. The method of claim 4, wherein said area of skin is on the face of a human.

11. The method of claim 9, wherein said area of skin is on a leg, an arm, an armpit or the torso of the human.

12. The method of claim 1, wherein said inhibitor is an irreversible inhibitor of a cysteine synthetic pathway enzyme.

13. The method of claim 1, wherein said inhibitor is a reversible inhibitor of a cysteine synthetic pathway enzyme.

20 14. A method according to any one of claims 1 to 13, wherein said applying of said inhibitor has a cosmetic effect.

15. A method of producing a composition for inhibiting mammalian hair growth, which
25 comprises selecting an inhibitor of a cysteine pathway enzyme, and combining said inhibitor, in an amount effective to reduce hair growth, with a non-toxic, dermatologically acceptable vehicle or carrier.

30 16. A method according to claim 15, wherein said vehicle or carrier is adapted to be spread upon the skin of a mammal.

17. A method according to claim 15, wherein a cosmetic composition is produced.

35 18. A method according to claim 15, wherein said inhibitor is as defined in any one of claims 2 to 8.

- 17 -

19. The new use of an inhibitor of a cysteine pathway enzyme for reducing hair growth.
20. A composition when used for inhibiting mammalian hair growth, which includes an inhibitor of a cysteine pathway enzyme in an amount effective to reduce hair growth, and a non-toxic, dermatologically acceptable vehicle or carrier.
- 5 21. A composition according to claim 20, wherein said inhibitor is as defined in any one of claims 2 to 8.
- 10 22. A composition according to claim 20, which is a cosmetic composition.

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61K7/06 A61K7/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,93 08687 (HANDELMAN,JOSEPH,H.) 13 May 1993 *Page7:claim 1* ---	1
A	WO,A,86 02269 (HANDELMAN,JOEPEH,H.) 24 April 1986 cited in the application *Page 14 :claim 1* & US,A,4 720 489 (SHANDER,DOUGLAS) ---	1
A	US,A,5 095 007 (GURPREET S. AHLUWALIA) 10 March 1992 cited in the application *Page 1: abstract* ---	1

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INTERNATIONAL SEARCH REPORT

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